INTERNATIONAL MARKETS FOR CCTs

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INTRODUCTION

The Role of the IEA

Let me start with a few remarks about the International Energy Agency.

The IEA was created in 1974, in response to the first oil shock to ensure its Members' collective energy security. At that time, the essence of energy security was seen as an uninterrupted oil supply.

Attention focused on developing emergency preparedness measures to respond to a major disruption in the international flow of crude oil, and on promoting long-term cooperation and research and development activities among Members to reduce their dependence on imported oil.

While these activities continue today as fundamental elements of the Agency's work, events of the last several years, in particular the end of the Cold War, have dramatically altered the world political and economic scene, and thus changed the basic environment in which world energy markets function:

- The economic restructuring under way in former communist countries, coupled with the expected continuation of strong incremental energy demand in non-OECD Asia and elsewhere in the developing world, will have significant effects upon both the supply and demand sides of international energy markets - these are now becoming truly "global".

- The resulting world energy balance is shifting, with the OECD now accounting for only half of global energy consumption.

- Energy markets generally have evolved, with deregulation and liberalisation resulting in their being driven more by market forces than through government intervention, although government involvement is clearly still required in certain instances.

- Environmental effects associated with the energy sector, from production through to consumption, have become increasingly vexing and compel innovative approaches to energy policy.

Importance of Coal

The response by energy policy makers to these challenges must draw on coal for a major contribution.

- Coal is one of the world's most important and abundant fossil fuels; its share of many countries' energy mix and the wide distribution of reserves around the world enhance diversity, and thus increase energy security.

- There is major scope for improving the efficiency with which coal is used and for mitigating the pollution and other emissions that its production and use can cause.

- Coal is low-cost compared with oil or gas, perhaps between a quarter and one-half the price for the same primary energy content. Many countries have economically viable domestic resources of coal to support economic development.

What is the IEA doing in the area of Clean Coal Technology?

The IEA Secretariat conducts a wide range of policy research, at the direction of its Members, on energy technology, energy-environment, and energy diversification issues. Much of this is concerned with advising governments on the market conditions required for optimising decisions on economic and energy-environment issues.

Important work of relevance to clean coal technology is also conducted by groups of our Member Countries, which come together to carry out work in areas of particular interest to them. These are known as Implementing Agreements. The oldest of these, IEA Coal Research - The Clean Coal Centre, publishes a wide range of studies, from basic coal science through exploration and production, to coal beneficiation, transport and use. The environmental dimension of each part of the coal chain is ever more important in the decision making process, and is therefore increasingly represented in IEA Coal Research publications.

Other Implementing Agreements on coal include:

- The Coal Combustion Sciences Agreement which is concerned with the basic science of coal combustion, including the development and application of analytical techniques for the analysis of coal combustion processes.

- The Fossil Fuel Multiphase-Flow Sciences Agreement, which coordinates the exchange of information and complementary research tasks in a wide range of research programmes to improv understanding of the behaviour and properties of multiphase phenonema associated with obtaining energy from coal, oil and gas.

- The Fluidised Bed Conversion Programme, which is sharing information about, and collaboratively researching, the physical and chemical processes which occur during fluidised bed conversion, in atmospheric and pressurised fluidised combustion beds, both bubbling and circulating.

Some recent highlights of our work show the approach we are taking in support of the clean coal technologies.

In early December, I led an IEA team at a conference on energy efficiency in Beijing, which we organised with the State Planning Commission. A major part of the conference was devoted to coal development, and coal utilisation in China. Papers presented by the IEA side sought to promote the clean and efficient production and use of coal.

Similarly, in October last year, we organised a joint workshop with the World Bank on the financing of clean coal technologies. The seminar brought together policy makers, financial institutions, equipment manufacturers, and research organisations.

In 1995, the US Department of Energy and other bodies sponsored an IEA Conference on *The Strategic Value of Fossil Fuels: Challenges and Responses*

We will shortly publish a major study on electricity in Asia, the *Asian Electricity Study*, which examines the electricity sectors in Indonesia, the Philippines, and Thailand. A chapter of the report is devoted to issues of power plant finance.

We have also published a number of reports covering coal issues generally. These include a report on the *Energy Policies of the Russian Federation* (1995), the *Energy Policies of South Africa* (1996), both with coal chapters. Each year we publish *Coal Information*, a major compilation of coal statistics with extensive commentary on coal production, demand and trade. The Coal Information series also provides current information on coal-fired power stations under construction and in planning throughout the world, including those using advanced power generation technology.

As a final example from many activities related to your conference, we have formal recognition at the on-going negotiations on climate change. We are at present developing advice for consideration at the Conference of the Parties (known as COP-3) to be held at the end of this year, and which could have a major bearing on the future of coal.

Role of the IEA Coal Industry Advisory Board

The IEA has a specialist industry source of advice on coal - the Coal Industry Advisory Board. The CIAB currently has 45 Members, representing coal industry interests from 16 countries. Members are corporate leaders from coal production, transport and utilisation companies.

Membership is not limited to OECD Member Countries. In 1995, the CIAB gained two new Members fro Africa, from Eskom and Ingwe. This year I hope we might make progress in gaining Members from Chin the world's largest producer of coal and a key player in international coal trade.

The CIAB is vitally concerned with promoting the use of clean coal technologies. The Board has produce a series of three reports published by the IEA* on clean coal technologies, examining industry attitudes to the take-up of both gasification/combined cycle, and advanced steam cycle technologies.

The CIAB studies confirm that there is a wide range of state-of-the-art coal-fired technologies suitable for different conditions in both developed and developing countries. These range from large scale supercritical steam-cycle power generation, through smaller scale fluidised bed plants for power generation and industrial heat, to IGCC technology which is under demonstration for very clean power generation.

Progress in installing such technologies is still slower than had been hoped and expected. Nevertheless, supercritical steam cycle plants are successfully established in Japan, Germany, and Denmark, and there is no shortage of industrial scale and demonstration plants for many of the other technologies.

The CIAB has been studying reasons for this slower progress and is now examining what may be done to accelerate the adoption of advanced coal-fired technology in different regions. The IEA expects to publish a new report from the CIAB, looking at the regional factors influencing the take-up of clean coal technologies, during 1997.

Context for discussing Clean Coal Technologies

The IEA's *World Energy Outlook*(1996) shows the secure future for coal.

We take two cases, which we call the Capacity Constraints case and the Energy Savings case. In the Capacity Constraints case trends in past behaviour are assumed to continue to dominate future energy consumption patterns. In the energy savings case energy consumers choose to use available energy efficient technology to an extent greater than has been seen in the past.

Three major conclusions can be drawn from the projections:

- First, world primary energy demand is expected to continue to grown steadily, as it has grown over the last two decades.

- Second, fossil based fuels will account for almost 90% of total primary energy demand in 2010.

- Third, a structural shift in the shares of different regions in world energy demand is likely to occur - the OECD share of world energy demand will fall in favour of the rest of the world, where the share of world primary energy demand is expected to rise from 28% now, to almost 40% in 2010.

In general terms, the outlook for coal in the world energy scene is for strong competition with gas, weakening demand for some coal uses, but continuing demand for baseload power generation.

Demand for solid fuels - principally coal - is expected to rise steadily in the outlook period to 2010 (at an average annual rate of 1.7% - 2.2%). Overall, the share of solid fuels in the primary fuel mix is likely to remain stable, but there will be significant changes in the pattern of world solid fuels consumption:

- Countries such as China and India, are very coal intensive. Growth in coal demand in the non-OECD countries could be as high as 3.8% per annum, and use in power generation could be as hig as 6% per annum.

- In the OECD countries, coal is expected to be increasingly a fuel for power generation. In 1993, the OECD was the largest fuel consuming region. By 2010, however, the OECD could acco for only just over one-third of world solid fuel consumption. The Rest of the World could consume more than on-half of world solid fuel.

The messages from our projections for your conference are:

- Coal has, and will retain, a central role in meeting the world's future energy needs.

- The growth area of coal use is in power generation.

- In OECD countries, coal's share in the electricity output mix will be maintained, but coal demand for other uses will fall.

- In the Rest of the World, coal will lose share in final energy consumption, but use in power generation will grow at over 6 percent per annum. The region where attention needs to be focused is Asia.

Technology Choices

Which Coal Technologies will be Chosen?

These messages are good news for coal producers, and seemingly so for coal technology developers and manufacturers. I mentioned earlier that the CIAB has expressed concern about the slower-than-expected take-up of the clean coal technologies. Let me review the evidence for this.

In the OECD countries, tighter emission standards are encouraging interest in clean coal technologies. But there is little prospect for growth in coal use in these countries taken as a whole.

Where growth prospects are greatest, in the Asia-Pacific region, Independent Power Producers are the key to power generation investment in the Asian region. The choices they make on technology will be

decisive in determining if clean coal technologies are used.

The CIAB has conducted a survey of Independent Power Producers (IPPs) in several regions, as part of the regional study I mentioned earlier. Sixteen companies involved in independent power generating project development and/or construction were surveyed. Several of the surveyed companies also represented technology supply or engineering/construction firms.

The survey found that at present, IPPs will choose mainly sub-critical pulverised-coal technology (that is, conventional coal-fired power generation technology), and in some cases Atmospheric Fluidised Bed (AFBC) technology. This technology can be clean and economic. Sulphur dioxide, NOx ar particulates can be reduced to acceptable levels, and provide low-cost electricity. At present, environmental standards, especially in developing economies, do not require environmental performance beyond the range of conventional plant with add-on pollution control.

Local and regional environmental problems from sulphur dioxide, NOx and particulates can be addressed by available technology, and there is a generally accepted policy framework for governments to adopt to ensure that emissions are controlled in an economically efficient manner.

As an aside, Flue Gas Desulphurisation at the power station would generally be regarded as the technology of choice for reducing sulphur dioxide emissions. This is not always the case. In China, for example, coal use is 70% in direct applications, and only 30% in power generation. During the IEA's recent conference on energy efficiency in China, which I mentioned earlier, coal preparation was described as the highest priority in clean coal technology for China because it would reduce emissions from direct use of coal.

However, on a global level, CO_2 emissions from power generation are becoming increasingly the focus of attention for energy policy makers. The higher levels of conversion efficiency which can be achieved by advanced steam cycle and gasification/combined cycle technologies, are desirable on global environmental grounds.

When asked what their expectations were for 2005, the IPPs responded that they would expect more supercritical steam cycle plants, and Pressurised Fluidised Bed Combustion (PFBC) in specialist uses, but Integrated Gasification Combined Cycle (IGCC) technology would not be in widespread use for coal before 2010.

The factors influencing these views were given as:

- Reliability, technology cost and financing constraints are the most important factors influencing the choice of technology.

- Government regulation, maintainability, technology risk and lender attitudes came a close second.

- Environment was not seen as a major determining factor. But environmental considerations would be important if contained in the category of government regulation, listed as important.

- Need for skilled operators came low on the list of factors, as IPPs felt it is not difficult to find and train them.

What are the problem areas?

The survey revealed that the advanced steam cycle technologies are considered to be commercially proven, but to be more costly and riskier, especially when built in non-OECD countries.

There are more than 350 supercritical units operating world-wide. Their early technical problems have been overcome and improvements incorporated in areas such as metallurgy, equipment design and water treatment. The reliability of these plants is now considered as good as for sub-critical plants. Nonetheless, the IPPs surveyed were cautious in selecting this form of clean coal technology.

IGCC was considered to be too costly to compete without some form of support.

Accelerating the Take-up of Clean Coal Technologies

What can be done?

In looking at what might be done to accelerate the use of the advanced clean coal power generation technologies, three points are clear:

- The regions where rapid growth in coal-fired power generation is occurring, are viewed by developers as having a different investment environment from the OECD countries. In short, there are more risks involved and, possibly, conventional risks are higher.

- Policies to encourage the take-up of advanced clean coal technologies need to be narrowly targeted, since the problems are different for the different parts of the world and for different technologies. Policies may need to be designed to suit particular regions and particular technologies.

- Governments should not be left to cope with the task. It is in the long-term interests of the coal industry to be actively involved.

General Prescription

There is a general prescription for encouraging the take-up of clean coal technologies in power generation:

- Electricity costs from plants *with* pollution control cannot be expected to drop dramatically, or drop below those *without* pollution control, unless completely new technologies are developed. These may be possible, but they are not on the horizon today.

- Consequently, clean coal technologies will be chosen when environmental regulations require them.

- Environmental regulations will be applied when environmental costs to society are recognised.

IEA Coal Research published a report in 1995, *Air Pollution Control Costs for Coal-fired Power Stations*, which quantified the cost of air pollution control costs for coal-fired power stations. They found that for new installations, the costs of sulphur dioxide and NOx control account for about 15% to 20% of the cost of electricity, depending on emission limits, the technology chosen and other technical and economic factors. Particulate control adds 3% to 4% to the cost of electricity.

It is unavoidable that as more stringent emissions controls are imposed, the cost of electricity also rises. For currently available technologies, the price rises steeply as different technologies are used to attain the next higher level of performance.

We know from the experience with control of sulphur dioxide, NOx, and particulates, that once Governments decide on minimum standards of performance, the market will choose the most cost-effecti way of meeting the standards. It is important to a cost-effective outcome that Governments do not attempt to impose the particular type of technology which should be used.

At the moment, there is no generally agreed standard which might encourage higher levels of conversion efficiency in plants. Economics determines the level of efficiency considered appropriate in a particular circumstance. As I have already commented, at present power developers in the high growth Asian economies are satisfied with the level of performance that can be attained by conventional sub-critical plant. They can meet all environmental requirements with this type of technology, with add-on pollution control such as Flue Gas Desulphurisation, if necessary.

In the absence of private economic incentive to use clean coal technology, then more advanced technologies will not be chosen until Governments choose to place a higher value on environmental performance, including carbon dioxide. Of course, developers might then turn away from coal if competing fuels, particularly gas, are more economic under a stricter environmental regime.

In the past, Governments have seen their role as supporting the take-up of new technologies in many fields, through direct financial support such as support for research and development, demonstration plants, and capital subsidies. There can be little doubt that programmes along these lines have advanced the technology and economics of clean coal power generation.

But enthusiasm for such measures is waning, under pressure of budget constraints.

Where clean coal technologies are commercially competitive, the situation is fairly straight forward. Governments have a role to develop sound environmental regulations, and to strive for undistorted energy markets where fuel prices reflect costs, including environmental costs.

For the technologies which are close to commercial or not yet generally accepted as proven, the situation is more complex, possibly calling for a range of policy measures.

Generally speaking, measures usually discussed all involve a degree of market intervention. We should be certain we understand the market before interventionist measures are implemented. At least three areas of the market need to be looked at:

- Is there genuine competition between electricity producers? Producers should be obliged by market conditions or regulation to look at the relative economics of the different technologies, and not be guided, say, to give preference to one form of technology over another because it is manufactured in the same country.

- Similarly, is there genuine competition between technology suppliers?

- Have external costs of power generation been taken into account?

Once we have a sound understanding of these points, we can look at measures governments might take to promote clean coal technologies.

A variety of measures have been proposed to complement the more traditional direct financial assistance measures. In listing these measures, I am not suggesting that the IEA necessarily gives its endorsement. Measures which have been proposed include, for example,

- Promotional measures to break down perception barriers concerning the use of coal, and to disseminate information on available, commercially proven, advanced clean coal technologies.

- Certainly, coal has a poor image and countries with major national interests in coal production have a particular responsibility here.

- The CIAB takes the view that there is insufficient understanding of the current reliability and economics of supercritical power generation technology, and has sought to address this by undertaking an analysis (still underway) of costs and other issues relevant in comparing sub-critical, supercritical and ultra-supercritical pulverised coal plants in non-OECD countries.

- Sharing the risk: This might take the form of Governments providing assurances against political risk for new developments, while manufacturers offer longer warranty periods to reduce technology risks. These measures would not be designed to direct a developer to a particular technology, but rather to ensure the developer's choice was not prejudiced.

- Developing "innovative" financing packages for new developments. This suggestion is based on the assumption that the risk-averse nature of lenders will influence technology choices.

- Activities Implemented Jointly (AIJ). AIJ has been proposed as a means by which countries might achieve reductions in global emissions of carbon dioxide, by projects and activities conducted outside their borders. The result could be a greater reduction in emissions, at lower cost, than the country might achieve within its own borders.

- In a comparison made by the CIAB, based on hypothetical 600 MW pulverised coal plants, the annual mass of carbon dioxide emissions for conventional, supercritical and ultra-supercritical plants are 5.2 million short tons, 4.8 million short tons, and 4.4 million short tons, respectively.

- This represents a reduction in emissions of 8% for supercritical, and 15% for ultra-supercritical plants, compared with conventional plant. There is scope for huge reductions in carbon dioxide emissions from Asia, through the use of these technologies.

These proposals are generally at the conceptual stage, and your conference would be making a major contribution if it could develop some ideas, either to further develop those I have listed, or as additional suggestions for promoting clean coal technologies.

The measures I have described should not necessarily replace all the more direct forms of encouragement I mentioned. Research and development, promotion of technology development and deployment, and technology cooperation are all proper roles for government in relation to coal technology. The decline in expenditure in these areas is to be regretted.

Nonetheless, industry has an important role in ensuring the future of coal. The coal industry needs to look to its own long-term interest, and companies along the length of the coal chain - from production to utilisation - should see that their interests are bound up in the future of the clean coal technologies.

At the end of this year, at the third Conference of the Parties on climate change, to be held in Japan, there is a very real prospect that legally binding targets on Greenhouse Gas emissions will be agreed. Such a proposal was put forward by the US Government at the second conference, held last year. If this is the outcome, then clean coal technologies will play a vital role in helping coal-fired power

generation meet the new standards expected, in those countries which are party to any agreement emerging.

It would be short-sighted to think that any agreement at COP-3 would not eventually impact on those countries not immediately involved in the climate negotiations. It would also be short-sighted to imagine that failure to agree at COP-3 will signal an end to the debate on energy-climate issues.

Today we might usefully focus on how the clean coal technologies can provide a constructive, and economic, response to maintain coal's prominent position in the world energy scene.

Thank you.

* *Industry Attitudes to Combined Cycle Clean Coal Technologies* (IEA OECD, 1994)
Industry Attitudes to Steam Cycle Clean Coal Technologies (IEA OECD, 1995)
Factors Affecting the Take-Up of Clean Coal Technologies (IEA OECD, 1996)